7.9 GEOLOGY, SOILS, AND SEISMICITY

7.9.1 Affected Environment

Physiography

The KTA ROI is on the northeastern part of the Ko'olau Mountains (including portions of KLOA), inland of the Kamehameha Highway, and does not extend to the shoreline. Elevations range from near sea level to about 1,860 feet (567 meters) msl. The topography varies from relatively flat on the coastal plains to nearly vertical bluffs on the cliffs to the east.

Geology

KTA is on the northernmost exposure of the Northwest Rift Zone of the Ko'olau Volcano (see Figure 3-10). Most of the area is underlain by basalt flows from the Ko'olau Volcano that were deposited at the end of its eruptive cycle, 1.8 to 2.6 million years before present (Stearns and Vaksvik 1935; Oki 1998). The Northwest Rift Zone contains dense volcanic dike intrusions, most of which are aligned in the same direction as the rift zone, on a northwest trend. Thus, the dike orientation tends to parallel the direction of streams and gulches in the northern part of KTA, but it tends to be perpendicular to the surface drainage and erosion pattern on the east and west.

Soils

Kahuku Training Area

Approximately the entire southern (upland) half of KTA is classified as Kapaa Silty Clay at 40 to 100 percent slopes (Figure 7-16). Kapaa soils occur on steep drainages, gulches, and ridgelines in mountainous areas with high rainfall. The soils developed in material weathered from volcanic rock, and on gentle slopes they are deep and well-drained and have fine to moderately fine subsoil (Foote et al. 1972). On steep slopes, runoff is very rapid and the erosion hazard is very severe. Most of the surface layer is removed by erosion.

In a broad band to the north of the Kapaa soils are found Paumalu-Badland Complex soils (Foote et al. 1972). Paumalu soils make up about 40 to 80 percent of the acreage in this complex. Runoff from Paumalu soils is medium to rapid and the erosion hazard is moderate to severe. Badland, which consists of nearly barren land that remains after the Paumalu soils are eroded away by wind or water, includes rocky and stony land. Runoff is rapid and the erosion hazard is very severe.

To the north of the band of Paumalū-Badland soils is another band dominated by Kemoo-Badland Complex soils but containing higher proportions of Kemoo silty clay at lower elevations with gentler slopes. Kemoo silty clay accounts for about 40 to 80 percent of the area covered by Kemoo-Badland Complex soils. Kemoo silty clay soils are well-drained red to dark reddish-brown blocky soils found on elevations between 300 and 1,200 feet (91 and 366 meters) where the rainfall ranges from 35 to 60 inches (89 to 152 centimeters). The

Figure 7-16
Soils Map Kahuku and Kawailoa Training Areas

erosion hazard depends on the slope. On steep slopes, runoff is medium to rapid, and the erosion hazard is moderate to severe. On gentle slopes (2 to 6 percent slopes) runoff is slow to medium and the erosion hazard is slight.

Preliminary ATTACC modeling results indicate that land condition at KTA is adversely affected by current training activities and that soil loss exceeds sustainable rates.

Drum Road/Kawailoa Training Area

As described in Section 7.8 for Water Resources, the ROI of the project for geologic resources within KLOA is contiguous with the ROI of the Drum Road portion of the project. Therefore, the discussion of the Affected Environment on the Drum Road route includes the portion of KLOA that would be influenced by the project. Figure 7-17 and 7-18 show the soils within a corridor of about 200 feet (61 meters) along Drum Road which runs through KLOA, between KTA and HMR. (Helemanō Trail, which continues from HMR to SBMR, is described in Section 5.9.)

Drum Road follows narrow ridges between watersheds along most of its route, occasionally crossing steep gulches to cross streams. From Kamehameha Highway to just east of Mount Kawela, the road is paved. A project is underway to improve the road, including paving or hardening the surface, widening the road, and making other improvements. The improved road will generally follow the existing alignment. The project would involve constructing tunnels in areas where sharp curves on steep slopes are otherwise unavoidable, using bridges and viaducts to widen the roadway in narrow areas, installing box culverts designed to accommodate a 10-year storm, and realigning the road to provide a maximum nine percent grade (slope). The road surface would be gravel, with compacted gravel shoulders. In some areas, it would be paved with asphalt to protect from erosion and formation of ruts.

From the end of the existing paved segment in the northern part of KTA, the road follows the ridgeline east of East ʻŌʻio Gulch and climbs from an elevation of about 900 feet (274 meters) to the crest of the range at an elevation of nearly 1,600 feet (488 meters). This ridge marks the boundary between the Koʻolau Loa and Waialua Districts and is the northern boundary of KLOA. The road follows the northern boundary of KLOA west to the head of Kaleleiki Stream. Along this six-mile-long segment the road passes initially over a small area of Paumalu silty clay (PeC), then crosses quickly into Paumalu-Badland complex (PZ). Above an elevation of about 1,000 feet (305 meters), it is in Kapaa silty clay on 40 to 100 percent slopes (KIG).

The Paumalu series soils are well-drained, gently rolling, silty clays developed in old alluvium and colluvium. As the slope increases, runoff and erosion hazard increases. The Paumalu-Badland complex occurs on 10 to 70 percent slopes and consists of 20 to 60 percent Badland, which is nearly barren land that remains after Paumalu soils are removed by wind and water erosion and consists largely of rock outcrops. The erosion hazard is very severe. The Kapaa silty clay soils have very rapid runoff and the erosion hazard is very severe. Most of the surface soil has been removed by erosion. In many ridge top areas, the surface has developed a thin subsurface ironstone sheet layer, about 10 to 18 inches (25 to 46 centimeters) below the surface, formed from precipitating iron minerals.

Figure 7-17
Soils Map Drum Road

Figure 7-18
Soils Map Drum Road and Helemanō Trail

As the road continues south along the western boundary of KLOA, it crosses Helemano silty clay soil on 30 to 90 percent slopes (HLMG), alternating with small amounts of Kapaa silty clay. The Helemano silty clay is developed on steep slopes on the sides of V-shaped gulches and includes areas of rock outcrops. The surface soil is dark reddish-brown, about 10 inches (25 centimeters) thick, and is underlain by about 50 inches (127 centimeters) of subsoil, with a blocky structure that is weathered in place from basalt rock. Permeability is moderately rapid, runoff is very rapid, and the erosion hazard is very severe.

The road continues south, following closely along the boundary of KLOA toward Pu‘ukapu, crossing from Helemanō silty clay soil to Rock Land (rRT). But after crossing the Kaiwiko’ele Stream, the road passes over some broader ridges underlain by Paaloa silty clay (PaC) on 3 to 12 percent slopes and Paaloa clay (PbC) on 2 to 12 percent slopes. The Paaloa soils are well-drained and on narrow upland areas bounded by steep gulches. The slopes are smooth. The surface layer is dark reddish-brown silty clay or clay and the substratum is subangular and blocky, developed in place in soft weathered basalt. Permeability is moderately rapid, runoff is slow to medium, and the erosion hazard is slight to moderate. These soils are used primarily for pasture and formerly for sugarcane.

As the road continues south it passes again across Rock Land, alternating with Helemano silty clay on 30 to 90 percent slopes. It also passes over a few narrow ridges underlain by Leilehua silty clay (LeB) on 2 to 6 percent slopes. The Leilehua soil is similar to the Paaloa soils in its occurrence on narrow ridges bounded by steep gulches, but it is developed on a more gravelly substratum. Runoff is slow, permeability is moderately rapid, and the erosion hazard is slight. The soil is used for pasture and formerly for sugarcane.

As the road continues south, it bends dramatically to avoid deep gulches and cultivated farmlands. As a result, the road follows along the rim of the gulches, crossing over steep slopes underlain by Helemano silty clay or Rock Land, alternating with gentler slopes on ridges underlain by Leilehua silty clay. It follows a course west along the north ridge of ‘Ōpae‘ula Stream and dips down from the rim elevation of about 1,200 feet (366 meters) into the stream gulch to cross the stream at an elevation of about 800 feet (244 meters). The gulch is underlain by Helemano silty clay. The remainder of the route to HMR traverses similar soils, alternating between Rock Land, Helemano silty clay in gulches, and either Leilehua silty clay soils or Paaloa soils on ridges.

Geologic Hazards

Kahuku Training Area

The high rainfall and runoff from the Ko‘olau Mountains has created many deep nearly straight gulches separated by long narrow ridges that radiate from the Ko‘olau Mountains toward the sea. The slopes in some of these gulches are nearly vertical and prone to rock slides. Figure 7-19 shows how much of KTA contains slopes greater than 30 percent, but many of these slopes are much steeper. Soils do not accumulate on the upper slopes, but the rock itself becomes weakened by weathering and sloughs off. Landslides in this terrain can occur unexpectedly, with no discernable trigger other than the weakening of the supporting

Figure 7-19
Steep Slopes at Kahuku Training Area

rock matrix by weathering. Earthquakes or vibrations from sonic booms may also trigger these failures (Jibson and Baum 1999). The rock rubble from these failures accumulates on the floors of the gulches and is ultimately carried downstream by runoff. The probability of earthquakes is about the same in KTA as it is elsewhere on O'ahu because most earthquakes are centered in the active volcanic areas beneath the Island of Hawai'i. The intensity of ground shaking, which is influenced by the underlying geologic materials, would be lowest in rocky upland areas and would probably increase somewhat on the lower slopes, where the thickness of the alluvial deposits is greatest.

Drum Road/Kawailoa Training Area

The route of Drum Road is mainly along ridges within KTA and alternates between ridges and gulches along the western boundary of the KLOA. The potential for slope failure is probably high on slopes underlain by saprolite (deeply weathered basalt that retains the appearance of the original rock but that does not have the strength of the rock). The saprolite forms steep slopes in stream gulches, but the slopes may be weakened if undercut at the base or if overloaded on top.

7.9.2 Environmental Consequences

Summary of Impacts

Impacts on geology and soils from the Proposed Action and No Action are summarized in Table 7-19. Significant and unmitigable impacts would occur from erosion and soil compaction caused by off-road Stryker training and other ground-disturbing activities. Significant impacts mitigable to less than significant would occur from soil erosion caused by wildland fires. Less than significant impacts would occur from erosion and slope failure caused by use of Drum Road.

Proposed Action (Preferred Alternative)

Significant Impacts

Impact 1: Soil loss from training activities. In areas with steep slopes, the use of off-road vehicles and other ground-disturbing activities may reduce vegetative soil cover and alter drainage patterns, which could lead to gullying. Steep slopes occur on the margins of the CACTF. ATTACC modeling of the maneuver training areas suggests that the effects on land condition would be severe after the Proposed Action is implemented. As described in Chapter 5, Section 5.9, soil compaction may also affect vegetation recovery, and create preferred drainage pathways along which erosion may be enhanced. Compaction is likely to occur in moist soils containing clays. Together, these effects are expected to be significant. These impacts would occur in addition to the ongoing erosion stresses due to public access and unauthorized use of portions of KTA described for the No Action Alternative. The mitigation measures below will substantially reduce the impact but not to less than significant levels.

Table 7-19
Summary of Potential Geologic Resources Impacts at KTA/KLOA

Impact Issues	Proposed Action		Reduced Land Acquisition		No Action	
	KTA	KLOA	KTA	KLOA	KTA	KLOA
Soil loss from training activities	⊗	○	⊗	○	⦸	○
Soil erosion and loss from wildland fires	⦸	○	⦸	⦸	⦸	○
Increased soil compaction	⊙	○	⊙	○	○	○
Exposure to contaminated soils	⊙	○	⊙	○	○	○
Slope failure	⊙	⊙	⊙	⊙	○	
Volcanic and seismic activity	⊙	○	⊙	○	⊙	○

In cases when there would be both beneficial and adverse impacts, both are shown on this table. Mitigation measures would only apply to adverse impacts.

LEGEND:

⊗	=	Significant	+	=	Beneficial impact
⦸	=	Significant but mitigable to less than significant	N/A	=	Not applicable
⊙	=	Less than significant			
○	=	No impact			

Regulatory and Administrative Mitigation 1. The Army will develop and implement a DuSMMoP for the training area, which will address measures such as, but not limited to, restrictions on the timing or type of training during high risk conditions, vegetation monitoring, soil monitoring, and buffer zones to minimize dust emissions in populated areas. The plan will determine how training will occur in order to keep fugitive dust emissions below CAA standards for PM_{10} and soil erosion and compaction to a minimum. The Army will monitor the impacts of training activities to ensure that emissions stay within the acceptable ranges as predicted and environmental problems do not result from excessive soil erosion or compaction. The plan will also define contingency measures to mitigate the impacts of training activities that exceed the acceptable ranges for dust emissions or soil compaction.

The Army will implement land management practices and procedures described in the ITAM annual work plan to reduce erosion impacts (US Army Hawai'i 2001a). Currently these measures include implementing a TRI program; implementing an ITAM program; implementing SRA program; developing and enforcing range regulations; implementing an Erosion and Sediment Control Management Plan; coordinating with other participants in the KMWP; and continuing to implement land rehabilitation projects, as needed, within the LRAM program. Examples of current LRAM activities at KTA include revegetation projects involving site preparation, liming, fertilization, seeding or hydroseeding, trees planting, irrigation, and mulching; a combat CTP; coordination through the TCCC on road maintenance projects; and development of mapping and GIS tools for identifying and tracking progress of mitigation measures.

Significant Impacts Mitigable to Less than Significant

Impact 2: Soil erosion and loss from wildland fires. At each of the installations, wildland fires have the potential for removing vegetation that protects soil from erosion. Wildland fires can affect large areas of land, removing grasses and larger trees and shrubs that hold the soil. The magnitude of this impact is directly related to the size of the fire. Fires may be initiated by detonation of munitions, or potentially even by vehicle engines, smoking, use of welding torches, by downed power lines, and many other causes. Land management practices can increase or reduce the potential damage caused by fires, through management of the fuel supply (wood, brush, grasses). Although naturally-caused fires are not common in Hawai'i, fires may also be started naturally, by electrical storms. Wildland fires are considered to be a potentially significant impact of all alternatives because of the potential for increased soil erosion.

Regulatory and Administrative Mitigation 2. The IWFMP for Pōhakoloa and O'ahu Training Areas was updated in October 2003. The Army will fully implement this plan for all existing and new training areas to reduce the impacts from wildland fires. The plan is available upon request.

Less than Significant Impacts

Slope failure - use of Drum Road. Use of Drum Road under the Proposed Action could result in slope failures due to vibration or loading, but the proposed improvements are expected to reduce these impacts compared to current conditions, and continued monitoring and maintenance of the new road would reduce any potential impacts from long-term use to less than significant levels.

Increased soil compaction. Soils in training areas, especially in areas that have not previously been used for maneuver training, are likely to become compacted by use of tracked or wheeled vehicles, potentially affecting the soils' ability to support vegetation and altering their permeability and moisture retention capacity. Widespread compaction could generally reduce recovery of vegetation cover. Preferred drainage pathways could develop along the compacted linear track left by off-road vehicles, creating increased erosion along the tracks. Drum Road will be used by the Proposed Action to transport vehicles and Soldiers to KTA. Portions of KTA are proposed as off-road maneuver areas under the Proposed Action. ATTACC modeling results suggest that a proportion of the land area in the maneuver areas could be affected. However, because KTA is currently used for current force training activities and is based on the level of predicted use by the Proposed Action, the modeling results predict a less than significant impact.

Exposure to soil contaminants. Since no live fire exercises would be conducted at KTA, no impacts from exposure to explosives or munitions-related chemical residues are expected.

Reduced Land Acquisition Alternative

The impacts associated with Reduced Land Acquisition are identical to those described for the Proposed Action.

No Action Alternative

Impact 1: Continued erosion caused by public use activities. Under the status quo of No Action, some of the existing erosion problems at KTA result from public access to portions of KTA and to unauthorized activities, such as off-road vehicle use and motocross riding on informal trails adjacent to the motocross raceway. Public use represents a source of potentially significant impacts on soil erosion that are comparable to military off-road impacts on soils. These impacts represent a potentially significant baseline impact on soil erosion.

Regulatory and Administrative Mitigation 1. The INRMP identifies management measures that could be implemented to reduce the impacts of public use, including better controlling access to sensitive areas, developing additional facilities, monitoring, and increasing enforcement of existing regulations.